Development of a High-Strength, Low-Cost Aluminum Piston Alloy

Jonathan A. Lee/EH23
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A technology partnership program to develop a new, high-strength, low-cost alloy for automobile engine pistons is being proposed jointly by NASA and Ford Motor Company of Dearborn, Michigan. This is a continuation of the Government's Partnership for a New Generation of Vehicles program with the U.S. automobile industry, in which NASA is playing an important role. The proposed new aluminum-alloy pistons are expected to withstand more heat than conventional piston materials, produce less air pollution, and may improve gas mileage. NASA's contribution to the effort will be performed by MSFC's Materials and Processes Laboratory.

Through a Space Act Agreement, MSFC/Ford's program objective is to formulate a low-cost, high-strength aluminum-silicon alloy to meet future automobile industry regulations for reducing exhaust emissions. The new piston alloy will have at least a 30-percent improvement in high-cycle fatigue strength when operating at temperatures as high as 300 °C. While some existing advanced, lightweight alloys and composite materials could be used to make pistons for high-temperature operations, these are too costly for broad commercial applications in the auto industry where low cost is a significant production factor. Today's typical piston materials cost is about $1 per pound. This program's target cost will be less than $2 per pound of material to develop a better performance piston for future U.S. auto engines.

The proposed 4-year piston development program calls for MSFC-led development for the first 2 years, with Ford taking over for the remainder. MSFC will perform an extensive literature survey of similar works that have already been accomplished, establish a material data base, develop the new piston alloy, and perform preliminary tests. Ford will lead in the development of new casting techniques, as well as in the design and manufacture of the new pistons. Several methodologies will be explored by MSFC in the attempt to formulate the advanced piston alloy, including various ways of changing the alloy microstructure to obtain the desired mechanical properties. Two of the most promising methods are dispersion strengthening and microalloying: dispersion strengthening entails blending aluminum alloys with finely dispersed carbide or oxide particles, while microalloying requires mixing a very minute amount of a special element in the alloy. The preliminary tensile and fatigue testing will be done at MSFC, with Ford doing the final piston testing and qualification. Under the present terms of the partnership, NASA and other federal government agencies will have the right to use the advanced alloy, as desired.

This program will combine NASA's materials expertise (advanced materials programs) with Ford's piston suppliers (casting technology) and Ford's experience in automotive engine design (piston qualification testing) in a cost-sharing, cooperative-development effort. The partnership between government and industry will enhance U.S. automobile competitiveness overseas. At the same time, the dual-use technology program will also benefit NASA and MSFC directly. For instance, the aluminum-silicon alloy developed from this program will have potential applications in NASA's reusable launch vehicle efforts, where low-cost, castable, high-strength aluminum alloys are required.

Sponsor: Office of Space Access and Technology

Industry Involvement: Ford Motor Company, Dearborn, Michigan